Neural Library

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- class InputNeuron
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  Type specific implementation of the neuron class for output neurons.

Chapter 5

Class Documentation

5.1 NeuralLibrary.Connection Class Reference

The connection held between two neurons with a given weight.

Public Member Functions

- Connection (double weightInitial, Neuron anteriorNeuron, Neuron posteriorNeuron)

  Initializes the connection.
- Connection (Neuron anteriorNeuron, Neuron posteriorNeuron)

  Initializes the connection with a random weight between -1 and 1
- void NudgeWeight ()

  Nudges the weights.
- void FeedForward ()

  Feeds the product of output from the anterior neuron and the weight of the connection forward to the anterior neuron.
- virtual void UpdateWeight (double learningRate, double momentum)

  Updates the weight of the connection using the weight update rule. dW = ERROR_posterior ∗ OUTPUT_anterior

Protected Attributes

- double lastDeltaWeight = 0

  The last delta weight (used for momentum)
- double **lastGradient** = 0
- double **acceleration** = 0

Properties

- Neuron AnteriorNeuron `[get, set]`

  The anterior neuron within the connection.
- Neuron PosteriorNeuron `[get, set]`

  The posterior neuron within the connection.
- double Gradient `[get]`

  Gets the gradient of the connection,

- double Weight [get, set]

  The weight associated with a connection.

5.1.1 Detailed Description

The connection held between two neurons with a given weight.

5.1.2 Constructor & Destructor Documentation

5.1.2.1 NeuralLibrary.Connection.Connection (double *weightInitial,* Neuron *anteriorNeuron,* Neuron *posteriorNeuron*) [inline]

Initializes the connection.

Parameters

weightInitial	The initial weight of the connection. Bound from -1, 1
anteriorNeuron	The neuron on the anterior side of the connection.
posteriorNeuron	The neuron on the posterior side of the connection.

5.1.2.2 NeuralLibrary.Connection.Connection (Neuron *anteriorNeuron,* Neuron *posteriorNeuron*) [inline]

Initializes the connection with a random weight between -1 and 1

Parameters

anteriorNeuron	The neuron on the anterior side of the connection.
posteriorNeuron	The neuron on the posterior side of the connection.

5.1.3 Member Function Documentation

5.1.3.1 void NeuralLibrary.Connection.FeedForward ( ) [inline]

Feeds the product of output from the anterior neuron and the weight of the connection forward to the anterior neuron.

5.1.3.2 void NeuralLibrary.Connection.NudgeWeight ( ) [inline]

Nudges the weights.

5.1.3.3 virtual void NeuralLibrary.Connection.UpdateWeight (double *learningRate,* double *momentum*) [inline], [virtual]

Updates the weight of the connection using the weight update rule. dW = ERROR_posterior $*$ OUTPUT_anterior

5.1.4 Member Data Documentation

5.1.4.1 double NeuralLibrary.Connection.lastDeltaWeight = 0 [protected]

The last delta weight (used for momentum)

5.1.5 Property Documentation

5.1.5.1 Neuron NeuralLibrary.Connection.AnteriorNeuron [get], [set]

The anterior neuron within the connection.

5.1.5.2 double NeuralLibrary.Connection.Gradient [get]

Gets the gradient of the connection,

5.1.5.3 Neuron NeuralLibrary.Connection.PosteriorNeuron [get], [set]

The posterior neuron within the connection.

5.1.5.4 double NeuralLibrary.Connection.Weight [get], [set]

The weight associated with a connection.

The documentation for this class was generated from the following file:

- Connection.cs

5.2 NeuralLibrary.DataPoint Class Reference

Public Member Functions

- **DataPoint** (double[] input, double[] desired)
- override string **ToString** ()

Properties

- double[] **Input** [get]
- double[] **Desired** [get]

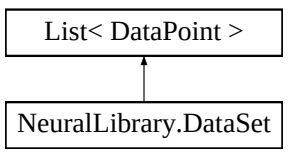
The documentation for this class was generated from the following file:

- DataPoint.cs

5.3 NeuralLibrary.DataSet Class Reference

Holds an abstract dataset.

Inheritance diagram for NeuralLibrary.DataSet:



Public Member Functions

- abstract void Load ()

  Load dataset into the list.
- DataSet Shuffle ()

  An extension for all ILists and dataset which shuffles the order.
- double[] CalculateErrors (Network nn, double step=-1)

  Calculates the errors based on the datapoints in a given dataset.
- double **CalculateError** (Network nn, double step=-1)

Static Public Attributes

- static Random r = new Random()

  Random used for the dataset extension (shuffle)

5.3.1 Detailed Description

Holds an abstract dataset.

5.3.2 Member Function Documentation

5.3.2.1 double [] NeuralLibrary.DataSet.CalculateErrors (Network *nn*, double *step* = -1) [inline]

Calculates the errors based on the datapoints in a given dataset.

Parameters

nn	The network from which to calculate the errors
step	The step size.

Returns

5.3.2.2 abstract void NeuralLibrary.DataSet.Load ( ) [pure virtual]

Load dataset into the list.

5.3.2.3 DataSet NeuralLibrary.DataSet.Shuffle ( ) [inline]

An extension for all ILists and dataset which shuffles the order.

Template Parameters

T	

Parameters

list	

5.3.3 Member Data Documentation

5.3.3.1 Random NeuralLibrary.DataSet.r = new Random() [static]

Random used for the dataset extension (shuffle)

The documentation for this class was generated from the following file:

- DataSet.cs

5.4 NeuralLibrary.FeatureMap Class Reference

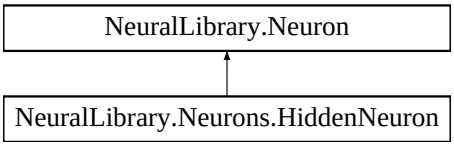
The documentation for this class was generated from the following file:

- FeatureMap.cs

5.5 NeuralLibrary.Neurons.HiddenNeuron Class Reference

Type specific implementation of the neuron class for hidden neurons.

Inheritance diagram for NeuralLibrary.Neurons.HiddenNeuron:



Additional Inherited Members

5.5.1 Detailed Description

Type specific implementation of the neuron class for hidden neurons.

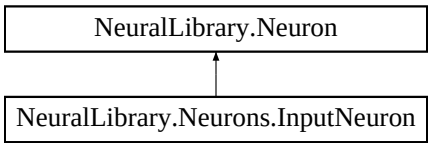
The documentation for this class was generated from the following file:

- Neurons/HiddenNeuron.cs

5.6 NeuralLibrary.Neurons.InputNeuron Class Reference

Type specific implementation of the neuron class for input neurons.

Inheritance diagram for NeuralLibrary.Neurons.InputNeuron:



Public Member Functions

- override void UpdateOutput (Sigmoid activation)

  Updates the inactivated net for output.

Properties

- override double **Output** `[get]`

5.6.1 Detailed Description

Type specific implementation of the neuron class for input neurons.

5.6.2 Member Function Documentation

5.6.2.1 override void NeuralLibrary.Neurons.InputNeuron.UpdateOutput (Sigmoid *activation*) `[inline],[virtual]`

Updates the inactivated net for output.

Reimplemented from NeuralLibrary.Neuron.

The documentation for this class was generated from the following file:

- Neurons/InputNeuron.cs

5.7 NeuralLibrary.Network Class Reference

Public Member Functions

- Network (bool RPROP=false, params int[] layers)

  Creates a network with default
- Network (int[] layers, Sigmoid[] activations, bool RPROP=false)

  Constructs a neural network with full control over activations.
- double Train (double[] input, double[] desired, double learningRate, double momentum)

  Trains the neural network using a given input and desired output set.
- void **Save** (string fileName)
- void NudgeWeights ()

  Nudges all of the weights in the network
- void FeedForward (double[] inputs)

  Feeds the network forward achieving an output for a given set of inputs.
- void BackPropagate (double[] desired)

Propagates the global error backwards through the network using the error backpropagation algorithm

- void UpdateWeights (double learningRate, double momentum)

  Updates all of the weights in the neural network based on neural error.
- Connection GetConnection (int layer, int anteriorNeuron, int posteriorNeuron)

  Gets a connection on a given layer with a given anterior and posterior neuron
- double[] GetWeights ()

  Gets an array of the ewights in the nwetwork.

Static Public Member Functions

- static Network Load (string fileName, bool RPROP=false)

  Loads a neurak network from a file.

Properties

- BiasNeuron Bias `[get, set]`

  The neural network's bias.
- double[] Input `[get]`

  Gets the input of the neural network.
- double[] Output `[get]`

  Gets the output of the neural network.
- double GlobalError `[get, set]`

  The global error of the network using some squared error.

5.7.1 Constructor & Destructor Documentation

5.7.1.1 NeuralLibrary.Network.Network (bool *RPROP* = `false`, params int[] *layers*) `[inline]`

Creates a network with default

Parameters

layers	

5.7.1.2 NeuralLibrary.Network.Network (int[] *layers*, Sigmoid[] *activations*, bool *RPROP* = `false`) `[inline]`

Constructs a neural network with full control over activations.

Parameters

layers	
activations	

5.7.2 Member Function Documentation

5.7.2.1 void NeuralLibrary.Network.BackPropagate (double[] *desired*) `[inline]`

Propagates the global error backwards through the network using the error backpropagation algorithm

Parameters

desired	The set of desired outputs to which the output neurons will be matched

5.7.2.2 void NeuralLibrary.Network.FeedForward (double[] *inputs*) [inline]

Feeds the network forward achieving an output for a given set of inputs.

Parameters

input	The set of inputs to be given to the input neurons.

5.7.2.3 Connection NeuralLibrary.Network.GetConnection (int *layer,* int *anteriorNeuron,* int *posteriorNeuron*) [inline]

Gets a connection on a given layer with a given anterior and posterior neuron

Parameters

layer	The layer on which hthe connection lies
anteriorNeuron	The anterior neuron ID
posteriorNeuron	The posterior neuron ID

Returns

5.7.2.4 double [] NeuralLibrary.Network.GetWeights ( ) [inline]

Gets an array of the ewights in the nwetwork.

Returns

5.7.2.5 static Network NeuralLibrary.Network.Load (string *fileName,* bool *RPROP* = false) [inline], [static]

Loads a neurak network from a file.

Parameters

fileName	The name of the file from which the network will be loaded.
RPROP	Whether or not the network will run the RPROP algorithm

Returns

5.7.2.6 void NeuralLibrary.Network.NudgeWeights ( ) [inline]

Nudges all of the weights in the network

5.7.2.7 double NeuralLibrary.Network.Train (double[] *input,* double[] *desired,* double *learningRate,* double *momentum*) [inline]

Trains the neural network using a given input and desired output set.

Parameters

input	The input
desired	The desired output of the neural network
learningRate	The rate at which weights will change
momentum	The momentum with which weight change occurs.

Returns

5.7.2.8 void NeuralLibrary.Network.UpdateWeights (double *learningRate,* double *momentum*) [inline]

Updates all of the weights in the neural network based on neural error.

5.7.3 Property Documentation

5.7.3.1 BiasNeuron NeuralLibrary.Network.Bias [get],[set]

The neural network's bias.

5.7.3.2 double NeuralLibrary.Network.GlobalError [get],[set]

The global error of the network using some squared error.

5.7.3.3 double [] NeuralLibrary.Network.Input [get]

Gets the input of the neural network.

Returns

An array of input values for the neural network.

5.7.3.4 double [] NeuralLibrary.Network.Output [get]

Gets the output of the neural network.

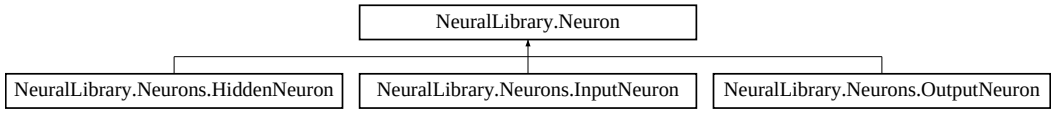
The documentation for this class was generated from the following file:

- Network.cs

5.8 NeuralLibrary.Neuron Class Reference

The base unit of the neural network. Contains pertinent information to neural nodes and feedforward propagation thereof.

Inheritance diagram for NeuralLibrary.Neuron:



Public Member Functions

- void Reset ()

  Resets the given neuron to its initial state.
- virtual void UpdateOutput (Sigmoid activation)

  Updates the output of the neuron.
- virtual void UpdateError (Sigmoid activation, double errorCoefficient)

  Updates the error of the neuron based on some activation function and some error coefficient (subject to change in Output Neurons).
- int **GetID** (Network network)

Properties

- double Net `[get, set]`

  The net input to the sigmoid function of the neuron.
- virtual double **Output** `[get, set]`
- double **Error** `[get, set]`

5.8.1 Detailed Description

The base unit of the neural network. Contains pertinent information to neural nodes and feedforward propagation thereof.

5.8.2 Member Function Documentation

5.8.2.1 void NeuralLibrary.Neuron.Reset ( ) `[inline]`

Resets the given neuron to its initial state.

5.8.2.2 virtual void NeuralLibrary.Neuron.UpdateError (Sigmoid *activation*, double *errorCoefficient*) `[inline], [virtual]`

Updates the error of the neuron based on some activation function and some error coefficient (subject to change in Output Neurons).

Parameters

activation	The activation function with which the error will be calculated.
errorCoefficient	The standard coefficient of error for neurons. SUM (for I in Posterior Neurons) Error_i $*$ W_ij. Where j is this neuron.

Returns

The neural error of the neuron.

Reimplemented in NeuralLibrary.Neurons.OutputNeuron.

5.8.2.3 virtual void NeuralLibrary.Neuron.UpdateOutput (Sigmoid *activation*) [inline],[virtual]

Updates the output of the neuron.

Parameters

activation	The activation function with which the output is calculated.

Returns

Reimplemented in NeuralLibrary.Neurons.InputNeuron.

5.8.3 Property Documentation

5.8.3.1 double NeuralLibrary.Neuron.Net [get],[set]

The net input to the sigmoid function of the neuron.

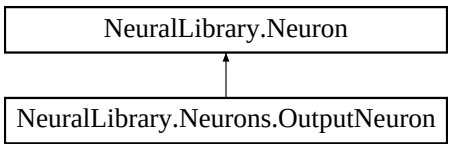
The documentation for this class was generated from the following file:

- Neuron.cs

5.9 NeuralLibrary.Neurons.OutputNeuron Class Reference

Type specific implementation of the neuron class for output neurons.

Inheritance diagram for NeuralLibrary.Neurons.OutputNeuron:



Public Member Functions

- override void UpdateError (Sigmoid activation, double desired)

  Updates the error of the output neuron based on some desired output and a sigmoid activation function.

Additional Inherited Members

5.9.1 Detailed Description

Type specific implementation of the neuron class for output neurons.

5.9.2 Member Function Documentation

5.9.2.1 override void NeuralLibrary.Neurons.OutputNeuron.UpdateError (Sigmoid *activation,* double *desired*) [inline], [virtual]

Updates the error of the output neuron based on some desired output and a sigmoid activation function.

Parameters

activation	The activation with which the output will be calculated/
desired	The desired output of this neuron for a given training set.

Reimplemented from NeuralLibrary.Neuron.

The documentation for this class was generated from the following file:

- Neurons/OutputNeuron.cs

5.10 NeuralLibrary.Sigmoid Class Reference

Defines some generic sigmoid activation function and its derivative.

Public Member Functions

- Sigmoid (Func< double, double > function, Func< double, double > derivative)

  Defines the sigmoid activation function by a function and its derivative.

Static Public Attributes

- static Sigmoid HyperbolicTangent

  The hyperbolic tangent activation function.
- static Sigmoid **HyperbolicStep**
- static Sigmoid **Logistic**
- static Sigmoid **Linear**
- static Sigmoid **None**

Properties

- Func< double, double > Derivative [get]

  The derivative of this sigmoid activation function.
- Func< double, double > Function [get]

  The definition for this sigmoid activation function.

5.10.1 Detailed Description

Defines some generic sigmoid activation function and its derivative.

5.10.2 Constructor & Destructor Documentation

5.10.2.1 NeuralLibrary.Sigmoid.Sigmoid (Func< double, double > *function,* Func< double, double > *derivative*) [inline]

Defines the sigmoid activation function by a function and its derivative.

Parameters

function	
derivative	

5.10.3 Member Data Documentation

5.10.3.1 Sigmoid NeuralLibrary.Sigmoid.HyperbolicStep [static]

Initial value:

```
=
            new Sigmoid(x => Math.Round(HyperbolicTangent.
      Function(x)),
                x => Math.Round(HyperbolicTangent.Derivative(x)))
```

5.10.3.2 Sigmoid NeuralLibrary.Sigmoid.HyperbolicTangent [static]

Initial value:

```
=
            new Sigmoid(x => Math.Tanh(x), x => 1 - Math.Pow(Math.Tanh(x), 2))
```

The hyperbolic tangent activation function.

5.10.3.3 Sigmoid NeuralLibrary.Sigmoid.Linear [static]

Initial value:

```
=
            new Sigmoid(x => x, x => 1)
```

5.10.3.4 Sigmoid NeuralLibrary.Sigmoid.Logistic [static]

Initial value:

```
=
            new Sigmoid(x => 1 / (1 + Math.Exp(-x)), x => Math.Exp(x) / Math.Pow(1 + Math.Exp(x), 2)
      )
```

5.10.3.5 Sigmoid NeuralLibrary.Sigmoid.None [static]

Initial value:

```
=
            new Sigmoid(x => 0, x => 0)
```

5.10.4 Property Documentation

5.10.4.1 Func<double, double> NeuralLibrary.Sigmoid.Derivative [get]

The derivative of this sigmoid activation function.

5.10.4.2 Func<double, double> NeuralLibrary.Sigmoid.Function [get]

The definition for this sigmoid activation function.

The documentation for this class was generated from the following file:

- Sigmoid.cs

5.11 NeuralLibrary.Trainer Class Reference

Trains the a neural network given a DataSet

Public Member Functions

- **Trainer** (Network network, DataSet trainingSet)
- **Trainer** (Network network, DataSet trainingSet, DataSet testingSet)
- bool Train (int epochs, double minimumError, double learningRate, double momentum, bool nudging=true, double stepPoint=-1, Func< bool > errorCheck=null)

  Treains the neural network over a given number of epochs using backpropagation.
- double Bound (double val, double min, double max)

  Bounds a double to a range.

Properties

- List< double > ErrorHistory [get, set]

  The error history for a given training session (nn);

5.11.1 Detailed Description

Trains the a neural network given a DataSet

5.11.2 Member Function Documentation

5.11.2.1 double NeuralLibrary.Trainer.Bound (double *val*, double *min*, double *max*) [inline]

Bounds a double to a range.

Parameters

val	
min	
max	

Returns

5.11.2.2 bool NeuralLibrary.Trainer.Train (int *epochs,* double *minimumError,* double *learningRate,* double *momentum,* bool *nudging* = `true`, double *stepPoint* = `-1`, Func< bool > *errorCheck* = `null`) `[inline]`

Treains the neural network over a given number of epochs using backpropagation.

Parameters

epochs	THe number of iterations to which the neural network will train before failing.
minimumError	The minimum error which the network must reach to
learningRate	The learning rate at which the network will begin to learn.
momentum	The momentum at which the network will begin to learn.
nudging	Enables nudging of the neural network during training.

Returns

Whether or not the network was sucessful in learning.

5.11.3 Property Documentation

5.11.3.1 List<double> NeuralLibrary.Trainer.ErrorHistory [get],[set]

The error history for a given training session (nn);

The documentation for this class was generated from the following file:

- Trainer.cs

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